form an important item in the exports from the country. The cocoa-nut thrives very well in the Seychelles, and plantations exist from the sandy beaches up the slopes of the mountains to elevations of from 1,000 to 1,500 feet. Tobacco was formerly much cultivated, and was of very fine quality, but the imposition of a tax on tobacco seems to have stopped the cultivation, and Mr. Horne says "the value of the tobacco grown would scarcely suffice to pay the tax, independently of the return which might be expected for their labour." Sugar-cane is cultivated to a small extent to make rum, but although the canes are magnificent, the yield of sugar is small and unremunerative. Cotton also grows remarkably well, but the cultivation has died out since the abolition of slavery, owing to the want of labour during the picking season. The chocolate plant grows freely on waste lands, and its culture is progressing. Vanilla has been planted in several places, and these plantations will shortly be bearing.

Maize and rice are but little cultivated, although in some places two crops of the latter might be obtained each year.

Spices, as cloves, cinnamon, nutmegs, allspice, and pepper thrive well. Clove trees are abundant and attain a height of 40 to 50 feet. The islanders gather the cloves in a reckless and extravagant manner, often felling the trees when the cloves might be reached by a bamboo ladder. The cinnamon is the bitter cinnamon, and is comparatively worthless. The nutmeg and allspice trees were introduced in 1871, and here thrive well. Pepper (*Piper nigrum*) is abundant, climbing over the granite boulders like ivy, and much might be made of it if a few Chinamen or Malays were introduced. Vegetables are very scarce, chiefly from the indolence or indifference of the inhabitants. Manioc and sweet potato are abundant, but yams are very little cultivated. The inhabitants obtain most of their food from the *Colocasia esculenta.* Arrowroot has been planted, and ginger, turmeric, and cardamoms might be easily cultivated. Mr. Horne recommends the rearing of silkworms and the cultivation of coffee. Mulberry-trees grow very readily, and coffee seems formerly to have been cultivated. The only drawback seems to be the want of labour. Pine-apples are abundant but of inferior quality, while oranges are common and excellent. Limes and bigarades are not uncommon, and lime-juice was formerly manufactured to some extent. Other tropical fruits, as anonas, bread-fruit, &c., are common.

During Mr. Horne's two visits he collected about 400 species of plants. About half that number are plants inhabiting all tropical countries, the greater portion of the other half will find congeners in Madagascar, Eastern Tropical Africa, Southern India, the Malay, Polynesian, or Oceanic Islands. The Flora of the Seychelles has no affinity to that of the Mauritius, and Mr. Horne considers that the relations to the Flora of Madagascar will be important from the similarity of geological formation and climate. He also thinks that the Seychelles Flora will have much in common with that of Eastern Tropical Africa. Mr. Horne's specimens have been sent to Kew, and will doubtless be described in the forthcoming Flora of Mauritius and the Seychelles. The Flora seems small, but vegetation is in many places scarce, owing to the occurrence of fires and from the ravages caused by the reckless felling of trees. Much of the ground is covered with dry Palm and Pandanus leaves, which easily take fire. The fire-tracks are readily distinguished by the age of the trees and shrubs now found growing on them.

The palms of the Seychelles are very interesting. The first is the Coco-de-Mer or Double Cocoa-nut. It abounds at Praslin, in a ravine, the highest trees measuring from 80 to 90 feet. The tree growing near the Government House at Port Victoria has flowered for the first time at about its thirty-fourth year. The other native palms of the Seychelles are all *spiny*, viz., a species of *Areca, Stevensonia grandifolia, Verschaffeltia splendida,* the "*Latanier Haubaum,*" and another undescribed species. *Areca rubra* (?), *Hyphœne* sp., and *Latania rubra* or *Borbonica*, have probably been introduced.

Articles, as hats, &c., of almost infinite variety are made from the young leaves of the Coco-de-Mer. The leaves of *Stevensonia* are used for thatch, and the split stems of *Verschaffeltia splendida* make excellent palisades. Ropes are made from the leaves of *Curculigo Sechellarum*, and fibre for cordage is got from *Paritium tiliaceum.* The fibre of *Fourcroya gigantea* (recently introduced) is made into fishing lines. The gum copal of Madagascar is got from *Hymenœa verrucosa*, a rare tree in the Seychelles.

Many useful timber trees are met with. The chief are the following :—

"Capucin," a species of *Sideroxylon.*
"Takamaka" (*Calophyllum inophyllum*).
"Bois de Fer," a species of *Dipterocarpeæ.*
"Gayac" (*Afzelia bijuga*).
"Badamier" (*Terminalia badamia*).
"Bois de Natte" (*Imbricaria petiolaris*).
"Bois Marée," a species of *Gomphandra.*
"Bois Rouge" (*Wormia ferruginea*).
"Bois de Table" (*Heriteria littoralis*).
"Sandal," a species of *Rubiaceæ.*
"Bois Montagne" (*Campanospermum Zeylanicum*).
"Cèdre" (*Casuarina equisetifolia*).

Mr. Horne carefully describes the uses of these timber trees.

The ordeal nut of Madagascar (*Tanghinia venenifera*) is met with in the Seychelles. It is a small tree about twenty feet in height, with large clusters of pretty white flowers having a pink centre.

Pigs are fed on the boiled roots of the *Colocasia macrorhiza* ; all parts of the plant are poisonous if unboiled.

Pitcher plants, *Pandani*, and species of *Loranthus* are common ; Ferns are tolerably numerous, and include the *Cyathea Sechellarum*, *Angiopteris evecta*, &c.

Mr. Horne recommends the Government to purchase the Coco-de-Mer ravine, to prevent the destruction of the trees, and he very properly adds, that "the destruction of the trees would be an outrage on science and a disgrace to civilisation."

Trees seem to be felled quite indiscriminately—a portion of the tree selected, the rest left to rot—so that now good trees are only to be found in the most inaccessible parts of the mountains. We trust that Mr. Horne's report will not be overlooked by the authorities ; otherwise we may soon expect to hear that the Seychelles are merely barren rocks and every trace of vegetation gone.

W. R. M'NAB

THE LOAN COLLECTION CONFERENCES

SECTION—PHYSICAL GEOGRAPHY, &c.

Opening Address by the President, John Evans, F.R.S.

IN opening the Conferences in connection with this Section of the Loan Exhibition of Scientific Apparatus, it will probably be expected that I should say a few words, if only by way of explanation, of the class of subjects that come within our range, which indeed are neither few nor unimportant. Let me first take the general list of subjects which have on the present occasion been grouped together, and which may be said to constitute our domain. These are Meteorology, Geography, Geology and Mining, Mineralogy, Crystallography, &c. Some of these subjects might no doubt with almost equal propriety have been assigned to other sections. Meteorology might for instance have been classed under the head of Physics and Mineralogy would not have been altogether alien to

the Section of Chemistry. There is, however, so close and intimate a relation between all the various branches of physical research, that it is not only difficult to draw exact boundaries between their provinces, but also to determine to which group any given province shall belong when it becomes necessary to map out the whole field of science into some four or five divisions.

Our province may be regarded in the main as comprising the physical history of the earth—the constitution of its mineral parts and the forms and characters they present when crystallized, the geological succession and nature of its component rocks; the past and present distribution of land and water, and the causes which have led to its modifications; and lastly those meteoric influences which not only affect climate, but are active causes in the carving out of the earth's surface and in the redistribution of the materials of which it is composed. Nor do we only take the purely scientific and theoretical portions of our subjects, but also the application of scientific principles to produce economic results, and to lessen the dangers of those who in the exercise of their calling meet the forces of nature under some of their most destructive aspects.

It is of course only with the apparatus which has been devised for the purpose of carrying on the investigations into the physical history of the earth, and the applications of scientific principles which I have just mentioned, that we are mainly concerned, and not with abstract questions relating to any branches of science. It may, however, be found necessary to enter more or less into such abstract questions if only to show the character of the investigations which have to be pursued, and to elucidate more fully the difficulties with which inquirers have had to contend, or which still have to be conquered. Such questions may also have to be discussed should the history of the gradual development of some of our modern appliances be gone into. Some of the earlier forms of instruments which are now exhibited are indeed of great interest, whether they are regarded in the light of what may be termed milestones on the road of scientific progress, or as memorials of the eminent men by whom they were devised or used. The goniometers of Hauy and Wollaston, the nascent safety-lamp of Davy, the blowpipe of Plattner, the barometer of De Luc and H. B. de Saussure, the thermometer of Gay Lussac, the geological maps of William Smith, the logbooks of Cook, Franklin, and Parry, the instruments and maps of Livingstone, are replete not only with scientific but historical interest.

It is, indeed, as constituting an epoch in the history of scientific discovery, that such a collection as that among which we are now assembled has its highest value and interest. The third quarter of the nineteenth century has just come to its end, and we may venture to compare the advances which have been made during the last twenty-five years not only in our own particular walks of science, but in every branch of it, with the advances which had been made during the previous quarter of a century, the close of which was marked by the first Great Exhibition held in London. Great as had been the progress in scientific knowledge and in the application of scientific principles during that second quarter of the century, and favourably as it contrasted with the by no means despicable attainments of the previous quarter, the advances made during the last twenty-five years both in our knowledge of the principles of the great forces of nature and in the accuracy and delicacy of our instruments for their investigation are such that the present generation has at least no cause to be ashamed of them. Possibly when another quarter of a century has elapsed, those who come after us and those among us who survive as labourers in the field of science, may look back upon some of the processes now in vogue as antiquated, and may even feel surprise at our having been upon the verge of some great discoveries and yet having failed to make them; but I venture to hope that the names of many of those living investigators which we find recorded in the Catalogue of this Exhibition may not only then, but even in after ages, be looked upon with reverence and esteem.

We must, however, turn to the consideration of the branches of science comprised under this Section, and in directing your attention to some of the objects which appear to me of more than common interest, I shall venture an occasional observation on some matters which appear to be well fitted for discussion at an international conference such as the present.

In regard to meteorological instruments we have not only isolated specimens but sets of instruments as supplied to meteorological stations, and to the royal and merchant ships of this country. With the exception of Russia, however, the means of comparison with other countries are, I believe, wanting. It will be for the representatives of other countries to see whether some useful hints may not be derived from the experience of British meteorologists as embodied in these selections of instruments.

Mr. R. H. Scott in the "Handbook to the Collection" has given so excellent an account of the nature of the meteorological instruments here exhibited that I need add but little to it, especially as he will be good enough to make a communication upon them.

Taking the principal forms it will be seen that among the barometers there are more than one exhibited which are of historical interest, while numerous examples of modern improvements in mercurial barometers are shown, of which perhaps those intended to facilitate their use and increase their accuracy when employed by travellers by land and by sea, are the most noteworthy. For ordinary use, however, that comparatively recent form of barometer, the Aneroid, seems likely to compete with the older form, and the precision of mechanism which some of them exhibit is marvellous. That extreme delicacy, however, has its disadvantages, and for trustworthy observations the actual weighing of the atmosphere by the column of mercury will long be preferred.

The principal features of the thermometers are their accuracy and sensitiveness. It might be worth while to consider whether any means could be devised for facilitating the adoption of a uniform scale of notation. It will, however, be a difficult matter to supersede the scale of Fahrenheit in this country, where it seems to have taken so deep a hold. The more general introduction of instruments marked with both Fahrenheit's and the centigrade scale might assist the adoption of the latter, but the smaller unit of heat on the former scale gives it practically some advantage.

Of anemometers, both for meteorological and mining purposes, a large number will have been seen, some of them furnished with means of recording both the direction and strength of the currents. Of several of these, details will be given at this Conference.

With respect to rain-gauges but little need be said; unless it be to call attention to the system, which, thanks to Mr. G. J. Symons, is now so universal in this country, viz., for observers who make only one daily entry of the rainfall, to take their observation at 9 A.M. and to enter the amount of rain to the preceding day. The late Meteorological Congress has no doubt discussed this and other points of international interest.

Of hygrometers, both ancient and modern forms are exhibited, the hair hygrometer still holding its own among those of the indirect class, notwithstanding the influences of modern civilisation. One cannot but be touched by the pathetic note of the Geneva Association for constructing scientific instruments. "The most isolated hamlets have now to be searched in order to obtain hair uncombed," and therefore fit for these instruments.

It is perhaps in the self-recording instruments that the greatest advance made during the last quarter of a century will be observed. The extended use of electricity and

photography has aided in this as much as in other departments of science, and the daily weather charts now issued in this country would have been impossibilities but a few years ago.

The automatic light-registering apparatus of Prof. Roscoe will it is hoped be the subject of a communication to the Conferences of this Section; but this and several other recording instruments are fully described in the Catalogue, as are also various interesting charts illustrative of meteorological influences on mortality and disease. The relation which has been found to subsist between colliery explosions and the state of the weather will form the subject of some observations to the Conference by Mr. Galloway.

There is only one other point in connection with meteorology on which I will say a few words:—that of evaporation. Two or three forms of atmometers or evaporimeters are exhibited, some of them intended to determine the quantity of water evaporated from different kinds of soil, but no form of instrument is, I believe, in the collection which will serve to ascertain the proportion of the rainfall which percolates to any given depth through a porous soil. When it is considered how large a proportion of the surface of the globe consists of such soils and how important is the question of the supply of spring-water to our wells and rivers, it will perhaps be a matter of surprise that more attention has not been directed to the subject. It is not, however, one on which to enter at length in an introductory address, though I hope to recur to it in the course of the afternoon.

The second subject comprised within our Section is that of Geography, which, thanks to our distinguished African, Asiatic, Arctic, and marine explorers is at the present time attracting so much public attention. Many of the instruments exhibited have much of historical and personal interest, among which may be reckoned the series of instruments belonging to the Ordnance Survey, some of them—like Ramsden's theodolites—exhibiting to what a point the construction of such instruments had advanced even at the end of the last century. What, however, will attract universal attention are the deep-sea sounding appliances, which have so greatly conduced to the success of the *Challenger* Expedition, and the great extension of our knowledge of the character of the deep-sea deposits of modern times, which throw so important a light on the history of many earlier geological formations.

This interest is much enhanced by the satisfaction we must all feel in again welcoming among us the distinguished naturalist who has had the scientific charge of that expedition. Let us all hope and trust that the gallant captain of the expedition during the first portion of its voyage, may in like manner return in due course with his present comrades from his still more adventurous exploration of the Arctic regions, crowned with the success which his efforts so well deserve.

Among the deep-sea sounding apparatus, that most ingenious invention of Dr. Siemens, the bathometer, which has been exhibited and described in another Section, will, no doubt, have attracted your attention, of which many of the levelling and surveying instruments exhibited in this Section are also so well worthy.

The collection of maps requires but little comment. The survey of Palestine, the charts of the Arctic Regions, the survey maps of India, and the beautifully executed maps sent from foreign countries cannot escape attention. In connection with recent explorations the remarkable section across Southern Africa, executed by Lieut. Cameron during the perilous journey from which he has just returned, will, I hope, be the subject of comment in these Conferences by its distinguished author. Nor should the ancient maps of the sources of the Nile exhibited by the Royal Geographical Society be left unnoticed. It might be a subject for discussion whether some more uniform system of symbols for use on maps might be adopted for general use among all nations.

In the department of Geology and Mining, it may be observed that the instruments of the pure geologist are but few and comparatively simple. We have, however, before us a most valuable collection of the geological maps of various countries, showing how vast has been the advance of our knowledge in this field during the last quarter of a century. The principles on which the geological survey of this country has been directed will be illustrated by its present accomplished chief, Prof. Ramsay, and we shall, I hope, hear something as to the surveys now going on in other countries. It would be a matter well worthy of consideration in an assembly of this kind, whether for the general geological features of a country, some international system of colouring could not be agreed upon, and in future be adopted. For more detailed maps entering minutely into the subdivisions of formations, such a system might be difficult to devise, much more to carry out; but for the principal formations there ought surely to be no great difficulty. Already, for something like two centuries, the colours in heraldry have been represented all over Europe by a conventional system of vertical, horizontal, oblique, and other lines, and science would not suffer if on this occasion she walked in the wake of vanity.

Among the appliances of the geologist must be reckoned his palæontological and mineralogical collections which, however, are, except in special instances, too bulky for an exhibition of this kind. Some are, however, here, and among them, a magnificent series of rocks, minerals, and fossils from Russia, and the fossil vegetable remains, both from the Continent and England, well deserve notice. We shall, I hope, hear from Baron von Ettingshausen how the genetic descent of much of the flora of the present day may be traced back into Tertiary times, and Mr. J. S. Gardner will have something to say on the same subject.

The sub-wealden boring, which has attained a depth of 1,900 feet, without, however, reaching any rocks of Palæozoic age, will also form a subject of comment. The process of the Diamond Rock Boring Company by which it has been carried on, has not only the advantage of being more expeditious than the older process, but has the great merit of producing such excellent cores as those which can be seen at the end of this gallery.

The ingenious machines of Mr. Sorby, illustrative of various geological phenomena, and the original drawings of Buckland and Phillips will also attract attention.

The specimens illustrative of M. Daubrée's experiments on the artificial formation of metamorphic and other rocks, and the minerals formed within the historical period by means of hot springs, will be rendered doubly attractive by the account to be given of them by that eminent geologist.

As objects of historical interest, however, the collections illustrative of the development of Davy's great invention of the safety-lamp, are perhaps unrivalled in this department. Among mining appliances and models, some few will form the subject of communications to the Conferences.

In the remaining department of this Section, that of Mineralogy and Crystallography, there is much of historical as well as scientific value. The improvements in the microscope, the polariscope, and the goniometer, have done much to advance these branches of science during the last quarter of a century, while the application of photography to the reproduction of the images observed in the microscope has most efficiently aided in bringing the results of single observers within the reach of all.

The models and diagrams illustrative of the different systems of crystallography and the various forms of crystals are remarkably excellent and complete, and some questions in connection with the properties of certain

forms of crystals, and the method of notation best adapted for international use, will probably be discussed in the Conference.

I have thus briefly touched upon some of the salient points which occur to the mind when taking a cursory view of an Exhibition such as the present. In doing so I have no doubt passed over many instruments and appliances of even greater importance than those which I have thus succinctly mentioned, and have probably left untouched many topics of the highest interest. Among the subjects, however, which will be discussed on each day of our Conferences there will, I hope, be a sufficient variety to give occasion for any one to call attention to any special features of novelty in the collection. What I have ventured to say must be regarded as merely a short introduction to communications of far greater value, from which I will no longer detain you.

SECTION—BIOLOGY

Opening Address by the President, Prof. J. Burdon Sanderson, M.D., LL.D., F.R.S.

It having been made a part of the duty of the chairman of each of the sections into which this Exhibition is divided to deliver an opening address, I had no difficulty in selecting a subject. I propose to place before you a short and very elementary account, addressed rather to those who are not specially acquainted with biology than to those who are devoted to the science, in which I shall give you a description of a few of the methods which are used in biological investigation, particularly with reference to the measurement and illustration of vital phenomena. You are aware that the Committee, in order to render these conferences as useful as possible, have thought it desirable that we should devote our attention chiefly to those subjects of which the instruments in the collection contribute the best examples.

Now these subjects are, first, the methods of registering and measuring the movements of plants and animals; secondly, the methods of investigating the eye as a physical instrument; and thirdly, the methods of preparing the tissues of plants and animals for microscopical examination. Of these several subjects it is proposed we should to-day concern ourselves chiefly with the first. I will therefore begin by endeavouring to illustrate to you some of the simplest methods of physiological measurement, particularly with reference to the *time* occupied in the phenomena of life, leaving the description of more complicated apparatus to Prof. Donders, who will address you on Monday, and to my friend, Prof. Marey, who is with you now, and who will give you an account of some of the beautiful instruments which he has contrived for this purpose.

The study of the life of plants and animals is in a very large measure an affair of measurement. To begin, let me observe that the *scientific* study of nature, as contrasted with that contemplation of natural objects which many people associate with the meaning of the word "naturalist," consists in comparing what is unknown with what is known. Whatever may be the object of our study—whether it be a country, a race, a plant, or an animal, it makes no difference in this respect, that the process in each of these cases is a process of comparison, a process in which we compare the object studied in respect of such of its features as interest us, with some known standard, and the completeness of our knowledge is to be judged of in the first place by the certainty of the standard which we use; and secondly, the accuracy of the modes of comparison which we employ. Now, when you think of it, comparison with a standard is simply another expression for measurement; and what I wish to impress is, that in biology, comparison with standards is quite as essential as it is in physics and in chemistry. Those of you who have attended the conferences on those subjects will have seen that a very large proportion of the work of the physical investigator consists in comparison with standards. From his work, our work, however, differs in this respect, that whereas he is very much engaged in establishing his own standards and in establishing the relations between one standard and another, we accept his standards as already established, and are content to use them as our starting-point in the investigation of the phenomena which concern us.

Now I wish to illustrate this by examples. The first objects which strike the eye on entering this collection—the collection in the next room—are certainly the microscopes. But you will say, surely the microscope cannot be regarded as an instrument of measurement. In so far as it is an instrument of research and not merely a pastime, it is emphatically an instrument of measurement, and I will endeavour to illustrate this by referring to one of the commonest objects of microscopic study, namely, the blood of a mammalian animal. Now as regards the blood I will assume that everybody knows that the blood is a fluid mass, in which solid particles float. With reference to the form of those particles, all that we see under the microscope is merely a circular outline. If we wish to find out what form that represents we must use methods which are really methods of measurement. By the successive application of such methods we learn that this apparently circular form really corresponds to a disc of peculiar bi-concave shape. But I will not dwell more upon the application of measurement to the form of the corpuscles, but proceed at once to a subject that can be illustrated by an instrument before you for ascertaining the *number* of the corpuscles. It will be obvious to you—even to those who are not acquainted with physiology and pathology—that the question of the proportion of corpuscles which are contained in the blood must be a matter of very great importance to determine. It has been long known that the colouring matter which is contained in the corpuscles is the most important agent in the most important vital processes of the body, because it is by means of it that oxygen, which is necessary to the life of every tissue is conveyed from the respiratory organs to the tissues. This being the case, it is evidently of very great importance both to the pathologist and to the man who interests himself in investigating the processes of nature, to be able to determine accurately what proportion of corpuscles the blood contains. Well, there are chemical methods of doing this. We can do it by determining how much iron the blood contains, because we know that the proportion of iron in the corpuscles is always nearly the same, and by determining the quantity of iron chemically, we can find out how many corpuscles there are in a certain amount of blood. But this is a long process, requiring first the employment of a considerable quantity of blood, and secondly, difficult chemical manipulations and a long time. Now by a method which has been very recently introduced, we have the means of applying the microscope even to a single drop of blood, to a drop such as one could obtain by pricking one's finger at any moment, or could take, in this way, from any patient in whom it might be desirable to ascertain the condition of the blood as regards the number of its solid particles.

The method consists in this. In order that you may understand it I will ask you to fix your attention upon this cube which I draw on the board. Suppose this cube is not of the size actually represented, but that it is a cube of one millimetre, *i.e.*, the $\frac{1}{25}$ part of an inch. How many blood corpuscles do you suppose are contained in a cube of that size? Such a cube we know to contain in normal blood about 5,000,000 corpuscles. Supposing we had a method by which we could count those 5,000,000 particles it is obvious that the task would be endless, and even if we were to take a cube $\frac{1}{125}$ part of that size, namely, a